Technical Report 714

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Training Courseware Enhancement and Refinement of the Hand-Held Tutor

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FOR THE BEHAVIORAL AND SOCIAL SCIENCES

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A previously developed hand-held vocabulary tutor was adapted to teach basic mathematics to combat engineers and fire commands to M1 tank commanders. Modifications were made in the hardware and internal software to make the tutor more useful in a training environment that went beyond simple vocabulary instruction. An existing set of instructional booklets was modified for presentation on the device. The modified materials were revised in accordance with findings from a formative evaluation, and the complete system was (Continued)

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then used in a small-scale field test, the results of which indicated that the device functioned as intended. Keywords:

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FOREWORD

The Curriculum and Evaluation Team of the Instructional Technology Systems Technical Area of the U.S. Army Research Institute for the Behavioral and Social Sciences performs research concerning military education and training. One facet of this research is the application of a portable, hand-held computerized tutor to a variety of Army training needs.

This report describes the application of the hand-held tutor, initially developed as a vocabulary tutor, to teach basic mathematics to combat engineers and fire commands to M1 tank commanders. Results of field testing indicate that the tutor is a very flexible device that could be used to present a variety of instructional materials.

This research effort was supported by the Education Division, Office of the Deputy Chief of Staff for Personnel (ODCSPER), and the Training and Doctrine Command.

EDGAR M. JOHNSON
Technical Director

TRAINING COURSEWARE ENHANCEMENT AND REFINEMENT OF THE HAND-HELD TUTOR

EXECUTIVE SUMMARY

Requirement:

In order to take full advantage of the very limited time and money available for field exercises or training in full-scale simulators, trainees should have already mastered as many elements of their jobs as possible before entering field or simulator training. Microcomputer/videodisk systems offer a partial solution, but cost and size restrictions typically limit their use to a handful of machines that must be kept at a fixed location. A low-cost, notebook-sized computerized tutor could provide additional training opportunities and still contain many of the benefits of larger fixed systems, including branching based on pretest scores, visual and auditory explanatory feedback, efficiently structured drill and practice activities, and game-like visual and auditory scoring features.

Procedure:

A previously developed hand-held vocabulary tutor was adapted for use in providing training for M1 fire commands. Modifications were made in the hardware and internal software to make the tutor more useful in a training environment that went well beyond simple vocabulary instruction. In addition, an existing set of instructional booklets was modified for presentation on the device. The modified materials were revised in accordance with findings from a formative evaluation, and the complete system was then used in a small-scale field test.

Findings:

The hardware and software modifications were all successfully accomplished The redesigned speech system resulted in a marked reduction in the amount of noise that was superimposed on the audio output. Internal software enhancements that were then used for the M1 fire commands curriculum included (a) modification of the menu routines to allow the inclusion or deletion of any of the courseware delivery components in any unit, (b) individual addressing of the SAY words, (c) enhancement of the random answer selection algorithms, (d) enhancement of the attribute files associated with each word or phrase, (e) absolute addressing of the basic vocabulary words, (f) modification of Word War phrase addressing to allow multiple references to an individual word, and (g) modification of display routines to allow the use of lower case letters. Field test results indicated that the hardware and courseware functioned as intended.

Utilization of Findings:

Assuming that the success of the limited field test reported here is replicated with a large-scale trial, this project suggests that the vocabulary tutor has now evolved into a very flexible device that can effectively present a variety of different kinds of materials, including instruction in giving fire commands for the M1 Tank.

TRAINING COURSEWARE ENHANCEMENT AND REFINEMENT OF THE HAND-HELD TUTOR

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TRAINING COURSEWARE ENHANCEMENT AND REFINEMENT OF HAND-HELD TUTOR

INTRODUCTION

Tank commanders on the M1 Abrams tank must be trained to evaluate very quickly a battlefield situation, identify the target which should be engaged first, choose the appropriate weapon and/or ammunition (from among three machine guns and two types of main gun ammunition), issue the appropriate fire command to the loader and gunner, direct the driver to move or change direction if necessary, and maintain communication with other tanks in the unit. For such complex tasks, realistic hands-on training is clearly essential to reach a level of effectiveness, or even survival, on the modern battlefield. But hands-on training is extremely expensive because of high costs of equipment and ammunition as well as the costs of transportation to the few areas that can support full-scale field exercises. In order to make better use of the very limited time for hands-on training or training in full-scale simulators, the commander trainees should have already mastered the basic prerequisite skills before going into the field. Thus, for example, if the trainee in the class practices basic elements of a fire command until they are virtually automatic, he is more likely to be able to use them correctly under the multiple pressures in the field environment.

The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) has been developing a number of approaches to making traditional education and training more effective. Several projects employ microcomputers combined with videodisks. Such systems are reasonably realistic and are relatively inexpensive compared with hands-on or full-scale simulator training, but they are still costly enough so that the amount of time a given soldier can spend working with the system is limited. In addition, such systems are not easily portable, so that soldiers must come to a fixed location at a fixed time to work with the system. Therefore, as a supplement to microcomputer/videodisk technologies, ARI sponsored the development of a low-cost, hand-held computerized Tutor. The intention was to make a device that was low enough in cost (under $150 in production quantities) and small enough in size (no larger than a notebook) so that it could be used by soldiers in much the same way that they could use a textbook or manual. The Tutor that was developed as a result of this initiative is a 10" x 11" x 2" device with a 32 character dot matrix display screen on the top, a keyboard on the bottom (numbers 0-9, letters A-E and three operational keys: SAY, ERASE and GO) and an indentation in the center that holds an open 5" x 5" booklet. The use of a printed booklet for the display of test questions, instructional text, and graphics permitted substantial cost savings compared to systems that store this type of textual and graphical information in the computer's memory and display it on a CRT. The Tutor also contains a digitized speech system. (For a more complete description of the Tutor see Fertner and Bridgeman, 1984.)

The Tutor was originally intended to teach technical vocabulary. Its three independent (but mutually supporting) courseware components are (a) an instructional sequence including a pretest and explanatory text with embedded questions, (b) a drill and practice session (called Word War) in which items answered incorrectly initially are presented again after just one other item has been presented, again after three more items have been presented, etc.,

(c) a game (called Picture Battle) requiring recognition of an appropriate picture (or portion of a picture) given a spoken stimulus. As an aid to assessment and training, the Tutor falls on a continuum between traditional paper-based materials and microcomputer/videodisk systems. The Tutor lacks the flexibility and moving graphics capabilities of interactive videodisks, but it is a fraction of the cost of such systems and is easily portable. Although the Tutor is more costly than purely paper-based materials, it provides a much more interesting and interactive environment for assessment and instruction: soldiers may be immediately branched to more difficult material based on pretest scores, visual and auditory explanatory feedback is provided, drill and practice exercises in which the item presentation order is varied depending on student performance are available, and interactions with game-like visual and auditory scoring features are included.

Because of the success of this approach for vocabulary instruction, ARI focused attention on other areas where this technology could be applied. One of these areas was instruction in issuing fire commands for M1 tank commanders. A contract was awarded to Educational Testing Service (and its subcontractors Advanced Technology Laboratories and BioTechnology Inc.) to adapt a set of existing instructional booklets for presentation on the Tutor and to make evolutionary enhancements to the Tutor's hardware.

Section 2 of this report describes the production of the hardware and the enhancements made to the Tutor's hardware and internal software/firmware; Section 3 describes the courseware development, and Section 4 presents results of the field test.

HARDWARE/SOFTWARE GENERATION AND PRODUCTION

The specification, development, production, and field testing of the ARI Vocabulary Tutor has shown that this technology is effective in increasing the educational ability of the military to deal with the ever-increasing complexity of weapons systems operation. From the evidence obtained so far, it can be said that the Tutor "concept" is a potentially successful way of dealing with the disparity between personnel ability and the requirements of military operations. Addressing the requirements of training scenerios, as contrasted to basic skills education, requires a format that is more procedurally oriented. To achieve this, the control program of the Tutor had to be modified to provide operation that is consistent with training requirements.

This section covers the development and production of the actual hardware and software for the support of the M1 and Mathematics modules. The M1 modules were provided in the modified format for training applications, while the Mathematics modules were provided in the standard Tutor format. Hence, the Mathematics modules are compatible with the original Tutor software and can be used in that environment. The M1 module, on the other hand, is compatible with the new software format only. Since the changes to the Tutor control program were significantly large, and compatibility between databases could not be maintained, the new machines were called Hand-Held Training Aids (HHTA's) to distinguish them from the previously-manufactured Tutors.

A modification to the power supply that provides better speech quality, quieter operation, and reduces user fatigue is described. Additionally, the enhancements to the control program that have been implemented on the delivered models to accommodate the more complex task of addressing training applications is discussed.

Power Supply Modification

The solid state circuits in the Tutor required both positive and negative voltages (+/- 5 volts) for operation. The power supplies in the Tutor consisted of a battery and electronic circuits to convert the battery terminal voltage to the required voltages for the solid state components. The power supply design utilized "switching" regulators to efficiently realize this conversion. Nickel-Cadmium (NiCad) batteries, as used in the Tutor, provide a nominal terminal voltage of 1.2 volts per cell when fully charged. Thus, a charged battery of four cells would provide 4.8 volts at its terminals. The terminal voltage typically drops to approximately 3.4 volts when the battery is discharged.

The original switching regulator design allowed the battery terminal voltage to be below the required power supply output voltage so that a minimum number of cells could be used. Regulation of the power supply output voltage at 5.0 volts while the battery voltage swung between its charged and discharged conditions was accomplished by varying the rate at which switching occurred.

During actual operation, the battery voltage came very close to the value of the regulated output. This happened immediately after fully charging the battery. When the two were close, the switching frequency fell into the audible spectrum. Compounding the situtation was the fact that there were two regulators operating simultaneously. The interaction between the two provided additional frequency components within the audible spectrum. The net result was a "whistle" or "rushing" noise that could be heard in the audio output of the Tutor. Circuitry was incorporated in the original design to mute the audio system during periods of speech inactivity; however, the noise was still apparent during times of actual speech output.

Design Modification. The power supply design was modified to improve the signal to noise ratio of the audio output of the Tutor without decreasing the overall efficiency of the power supply system. Additional types of switching regulator integrated circuits were investigated, but the cost/performance ratios of other parts did not match that of the original chip. It was therefore decided to utilize the existing chip, but operate it in a different mode. To accomplish the desired noise reduction, the feedback mode was changed from frequency modulation to pulse width modulation. In this mode of operation, variations in the voltage output from the power supply would result in a change in the pulse width of the control signal, but not its frequency. The resulting design yielded operation at a single frequency above the audio spectrum and allowed superior filtering of the audio frequency components.

Additional reduction of audible noise was achieved by eliminating the negative voltage regulator (the Tutor actually used two separate power supplies) and replacing it with a charge pump. Both voltages were therefore generated using a single frequency. This eliminated the herterodyning of the positive and negative supply switching frequencies that was an attending problem in the original Tutor design.

Result. The result of the design effort was a marked reduction in the amount of noise that was superimposed on the audio output. This provided clean-sounding speech that was easily understood. Additionally, the reduction in noise appears to provide operation that is less tiring during long listening periods. The total parts count for the new design remained about the same; however, relatively costly components consisting of a transistor, a switching inductor, and a switching regulator IC were eliminated. This resulted in about a 20 percent reduction in the power supply component cost.

Operation. The performance and efficiency of the new regulator circuit very closely approximated those of the original design using frequency modulation. One exception is that, as the battery voltage goes above 5 volts during charging, the negative output voltage of the new design starts to fall. It remained constant in the original design. The positive output voltage of the new power supply, on the other hand, maintains a constant output of 5 volts almost to a battery voltage of 6 volts. The original regulator design allowed the positive voltage to rise above 5 volts as the battery voltage rose during recharging. Table 1 shows a tabulation of the measured performance of the new power supply design, as installed in a standard Tutor. Table 2 shows the performance characteristics of the original design operating in the same hardware environment.

Table 1

Performance of New Power Supply Design

Time Elapsed	Battery Voltage	Positive Output	Negative Output	Comments
start	5.61	5.02	-4.75	negative regulator out of regulation
1 hour	5.23	5.04	-5.02	
2 hours	5.09	5.02	-5.05	
3 hours	5.07	5.02	-5.06	
4 hours	5.06	5.04	-5.08	
5 hours	5.05	5.05	-5.09	
6 hours	5.02	5.05	-5.06	
7 hours	4.08	5.05	-5.08	
8 hours	4.93	5.05	-5.09	
9 hours	4.46	5.07	-5.20	battery rapidly discharges

Table 2

Original Power Supply Design Performance

Time Elapsed	Battery Voltage	Positive Output	Negative Output	Comments
start				
1 hour	5.80	5.17	-4.96	negative regulator cannot regulate at 5 volts
2 hours	5.28	5.17	-4.96	
3 hours	5.07	5.17	-4.96	
4 hours	5.05	5.17	-4.96	
5 hours	5.05	5.17	-4.96	
6 hours	5.04	5.17	-4.96	
7 hours	5.02	5.18	-4.96	
8 hours	4.98	5.17	-4.96	
9 hours	4.48	4.88	-4.96	battery voltage drops off rapidly

Software Modification

Although the actual modification of the control software contained in the HHTA was developed on another contract, the specifics of the enhanced characteristics are included here to provide documentation of the changes in performance of the machine over that of the Tutor. In general, the changes relate to the added demands placed on a delivery system when dealing with procedural materials over those necessary for the teaching of MOS-related vocabulary.

Seven specific areas were selected for modification based on a combination of the new requirements and costs consistent with the development of a new curriculum. These changes can therefore be viewed as a significant

"first step" in the overall enhancement of the capabilities of the machine. They include: a) modification of the menu routines to allow the inclusion or deletion of any of the courseware delivery components in any unit, b) individual addressing of the SAY words, c) enhancement of the random answer selection algorithms, d) enhancement of the attribute files associated with each word or phrase, e) absolute addressing of the basic vocabulary words, f) modification of Word War phrase addressing to allow multiple references to an individual word, and g) modification of display routines to allow the use of lower case letters.

Menu Modification. The menu entries in the original Tutor were fixed. Unit I mandated the selection of Pretest or Picture Battle, while the remainder of the units mandated the selection of Pretest, Word War, or Picture Battle. In other words, unit one had to have a Pretest and a Picture Battle present to function, while all other units had to have all three courseware elements. There was no provision for variation of the elements from unit to unit. In procedural work, as in training, the information contained in some units may not lend itself to one or more of the elements at all. A method by which to address the individual requirements of each unit in a courseware module individually would allow the optimization of the machine resources for a given training session. This was accomplished by modifying the control program to allow control of menu entries by data contained in the Plug-in Module. The presence of any of the three courseware elements (Pretest, Word War, or Picture Battle) is therefore under the control of the courseware designer. The format of the Module data was modified accordingly to accommodate the additional coding.

SAY Word Indirect Addressing. *In the Vocabulary Tutor*, there was a one-to-one correspondance between the SAY words and the Words contained in the vocabulary word list. This was sensible and efficient for the teaching of vocabulary, but in training scenerios, many words are used over and over again. To store each word again for each occurrence during presentation of the courseware materials is extemely inefficient. This shortcoming was evident even in the Mathematics Module where the same number was used up to 8 times, not including concatinations. To minimize memory requirements under repeated word conditions, therefore, the SAY word absolute addresses were removed from a direct lookup table containing the starting addresses of each Word to an indirect listing table containing the starting addresses of each individual word (or short phrase) contained in a given phrase. The table contains enough information to allow the HHTA main processor to determine how many words or short phrases are contained in the desired phrase and the exact memory location of each. The method allows the same word to be included in many different phrases without significantly increasing the memory requirements.

Random Number Generator. The algorithm used to randomly select the answer order and distractors during Word War sessions was modified to eliminate a bias toward the selection of the first answer as being correct. This modification is actually transparent to the casual user.

Word Attribute File Enhancement. It has become evident that in applications subsequent to the MOS 13B Module, there was a need to more finely

categorize words within the vocabulary to allow the selection of distractors that were similar to the correct answers. This was especially true when single words were used many times, as in the Mathematics Module, where use of the same number over 8 different times resulted in the inclusion of distractors in word groups that contained attributes significantly different from the desired word. To allow more repetition in the use of words, and to provide more subtle differences between distractors, the "tag" for each word used in Word War to determine its attributes with respect to sameness was removed from the word address data to a separate field in the display data section of the database. This allows an increase in the number of distractor groups from the original 8 to 256.

Absolute Word Addressing. The original algorithms used in Word War yielded an orderly progression through the units with a Word War in each unit, excluding the first. Due to the orderly format of the vocabulary requirement, an efficient algorithm was designed for the selection of the 10 Word War questions for each unit. This was accomplished by specifying the address of the last word to be used (highest memory starting address) and selecting the nine lower starting addresses for the 9 other words to round out the requirement for 10 words in each session.

In a training application, the same word can be used again and again as was previously discussed. A better approach would then be to allow the selection of any set of 10 words, under the control of the courseware designer. Then either an orderly progression of new data can be accommodated as was previously done, or courseware in which current sessions build on past sessions and contain redundant data can be easily handled.

To enhance the word addressing scheme, each word was assigned an absolute address. Each Word War was assigned a lookup table that contained the starting address of each desired word and the order in which the words were to be called. This format allows any word in the vocabulary to be called up from any unit during Word War and to be used in any desired sequence.

Word War Phrase Addressing. In vocabulary applications, there was always a one-to-one correspondance between a word and its definition. Subsequent uses of the Word War function have lead to instances where a spoken word can have multiple correct definitions. The original software required a word per definition, which included repeated words if multiple definitions were required. This proved wasteful in applications such as the M1 materials. To increase the efficiency of memory useage under these conditions, a new field containing a definition look-up table was added to the answer key section of the database. This table allowed a single spoken word to have multiple definitions, all of which are correct.

Display routines. A memory-conserving algorithm was originally used to store the display data. The routine utilized lowercase letters embedded within the displayed words to indicate the end of the word or a space in the phrase. This precluded the use of lowercase letters in the displayed data. The routine was modified to read and display the data exactly as contained in the database. This increased the memory requirements slightly, in that all spaces had to be present in the data base; however, the increase in function more than outweighted the greater memory useage.

Database modifications. The database contained in the plug-in module had to be modified to accommodate the software enhancements. Three fields were added to the base table addressing. One byte of data for module type identification was placed at the lowest address. The number one was reserved for current standard modules. Two additional base addresses were established for speech words and the SAY word concatenation table. A title area was added above the base table. A message stored in the title area is displayed on the HHTA display screen on power-up.

Housekeeping word addressing was moved up to the plug-in module from the main HHTA board memory to facilitate changing formats for the encoded speech words.

Menu decode tables were added to the program prom in the plug-in module, along with an additional byte in the unit answer section for menu decoding. These tables are built during authoring to allow the selection of menu contents for each unit.

A multiple phrase decode list was added to accommodate multiple definitions for a single spoken word. A stop code was also added to the end of all spoken word answer lists to facilitate Word War searching.

HHTA Production

The combination of the power supply and software modifications and the resulting incompatibility between the new machines and the original Tutors made it mandatory to distinctively set the new units apart from the original systems. The new cases were manufactured in black to allow easy identification of systems with the new software. Also, to indicate the greater utilization of procedurally-oriented materials in the control software, the new systems were designated HHTA for Hand-Held Training Aid. M1 tank materials generated under this contract are compatible with the HHTA, while the Mathematics Modules were produced for, and are compatible with, the original Tutors. Twenty HHTA's were produced and delivered under this contract.

Hardware. The modified power supply design was incorporated into a single unit and demonstrated to ARI personnel. On approval of the performance, the HHTA printed circuit board (PCB) design was modified to accommodate the new power supply design. Additionally, some of the areas on the PCB that proved to be problematic in production were also modified to improve the production yield. Specifically, the conductor spacing in several places on the board was increased to reduce the incidence of solder bridging during wave soldering. The batteries used in the HHTA were welded cell construction rather than individual cells in a pressure holder, as was used in the original design. The remainder of the hardware production was consistent with the original Tutor specification. All units were tested with the new M1 Plug-in Modules at ATL's facilities prior to shipping.

Software. The modified software control program was programmed into 2564 erasable, programmable read only memory (EPROM) for installation on the main

HHTA PCB. The original Tutor was designed to accept a 2532A EPROM as standard and a 2564 as an option. Installation of the option required changing the EPROM option jumpers on the PCB to the 2564 positions on the main board. This change to a larger memory chip was necessitated by the larger control software program which could no longer fit into the smaller Tutor EPROM.

Mathematics Plug-in Module Production

Twenty Mathematics Plug-in Modules compatible with the original Tutor format were produced, based on the contractional specifications. The courseware materials relating to display information and answer keys were generated using ATL's Tutor authoring system. Originally, speech data for the module was obtaining from Texas Instruments (TI). However, the quality of the material produced by TI was not good enough to use in the final product. The extent of the problem was discussed with TI personnel, and a second cut at the speech material was made. This second cut was not acceptable either. At this point, ATL decided to generate a sample module using a standard vocabulary data base. This was accomplished on the ATL authoring system by concatenating standard words to synthesize the required phrase. Three sample Plug-Modules were generated with this data and distributed to ETS and ARI. The consensus of opinion was that the ATL-synthesized data was better than the material specifically generated for the module.

With TI's approval, the ATL-synthesized data was used in the final product. Three words not available in the vocabulary database were taken from the wordlist encoded for this contract. A request was made to TI to adjust the speech encoding fees accordingly.

The following is the list of words used in the synthesis of the entire vocabulary for the mathematics Plug-in Module:

zero	seven
one	eight
two	nine
three	positive
four	negative
five	number
six	over

All spoken words used in the delivery of the courseware materials were formed by concatenating combinations of the above words to create the complete phrases. For instance "-5" was created by stringing "negative" and "five" together. Fractions were generated using "over" to indicate the fraction bar. For example, "four fifths" was expressed as "four over five".

The actual concatenation was performed on ATL's authoring system and each of the phrases was stored in its final form. A total of 142 words were synthesized for this application.

The resulting object code generated by the authoring system was then programmed into the speech data EPROMS using a production "gang" programmer.

The EPROMS were then assembled into the plug-in modules. The module hardware was manufactured to the same specification as the original Tutor.

M1 Procedural Guide Plug-in Module Production

Software Production. Due to the enhanced control program, and the requirement for the M1 Plug-in Module to be compatible with the HHTA, all data developed for the M1 was generated in the new data format. Essentially, authoring was accomplished in the same manner as for the Mathematics Module, except that words used more than once were simply assigned a single space in the database instead of replicating each word for each use in the courseware delivery. The ability to use a given word in the database many times offered a net savings in memory requirements. In the case of the M1 materials, it allowed more phrases to be used during courseware delivery than would have been possible in the original format.

As in the case of the Mathematics Module, the authored materials were programmed into the EPROMS resident in the plug-in module. A single module was produced and validated. The remainder of the EPROMS were then programmed via the production programmer associated with the Authoring System.

Generated Vocabulary. The following is a listing of the complete wordlist for the M1 application. This represents a single entry for each word or phrase used in the delivery of the courseware materials. Where appropriate, the associated definitions are also included. The Group number represents the entry in the distractor attribute file. This is used by the HHTA in the random selection of distractors that are plausible for a given question. Total attribute groups available in the HHTA is 256.

Additional phrases, concatenations, and repeats of some of those listed are accomplished by the HHTA software on an "as needed" basis.

NO.	WORD	DEFINITION(S)	GROUP
1	MI-10	Heavy Lift Chopper	1
2	ASU-85	Assault Gun	1
3	T-72	Tank	1
4	SP-122	Self-Propelled Howitzer	
5	RPG-7	Rocket-Propelled Grenade	
6	T-12	Antitank Gun	1
7	SPG-9	Recoiless Antitank Gun	
8	SAGGER	Antitank Guided Missile	
9	BDRM	APC	
10	HIND	Helicopter	
11	MI-6	Heavy Lift Chopper	
12	HIND-D	Heavily Armored Chopper	1
13	BM-21	Truck	1
14	MIG-23	Aircraft	1
15	APC	Armored Personnel Carrier	1
16	PT-76	Light Tank	
17	T-62	Tank	
18	BMP	Personnel Carrier	1

NO.	WORD	DEFINITION(S)	GROUP
19	T-12A	Antitank Gun	
20	HEAT	T-72, 2000M, 2nd Best	
*		HIND-D, 700M, 2nd Best	
*		BDRM, 1500M, Best	
21	SABOT	T-72, 1700M, Best	
*		152MM Howitzer, 2500M, Best	
*		T-12A, 2000M, 2nd Best	
*		BMP, 1000M, 2nd Best	
*		HIND, 2500M, Best	
*		T-62, 1400M, Best	
*		PT-76, 1200M, Best	
*		ASU-85, 2000M, 2nd Best	
22	COAX	RPG, 750M, Best	
*		Truck, 800M, Best	
*		BM-21 Truck, 400M Best	
*		Machineguns, 500M, Best	
23	LOADER'S M240	MIG-23, Low Level, 2nd Best	
24	CAL .50	Manpack SAGGER, 1800M, Best	
*		Troops, 1500M, Best	
*		MIG-23, Low Level, Best	
*		RPG-7, 1000M, Best	
25	TANK	Tank-Like Target	
*		Howitzer SP	
26	TRUCK	Wheeled Vehical	
27	PC	Armored Personnel Carrier	
28	CHOPPER	Helicopter	
29	PLANE	Fixed-Wing Aircraft	
30	TROOPS	Personnel	
31	MACHINEGUN	Machinegun	
32	ANTITANK	Towed Artillery Piece	
*		Antitank Gun	
33	WRONG		
34	NO		
35	INCORRECT		
36	CORRECT		
37	TRY AGAIN		
38	Most Dangerous Threat		
39	Has Not Seen You		
40	Cannot Kill You		
41	Too Far Away		
42	HEAT is second best		
43	Dangerous Threat		
44	Least Dangerous Threat		
45	Most Dangerous		
46	MI-6 Cannot Kill You		
47	Dangerous		
48	Initial Fire Command		
49	What's Wrong Here		
50	Incorrect Sequence		
51	Wrong Target Discription		

NO.	WORD	DEFINITION(S)	GROUP
52	Will Reload HEAT		
53	Will lose too much time		
54	Time to change		
55	Improper elements		
56	Fire adjustment command		
57	Next fire command		
58	What should you do		

In addition to the above word list, the standard Tutor "housekeeping" words were also included. The housekeeping words were encoded along with the M vocabulary to provide a consistent speech presentation (the same speaker was used for all spoken data).

Speech Encoding. Both the M1 word list and the housekeeping words were encoded on ATL's speech authoring system. Use of this system allowed a fast turn-around and modification of the spoken words a short time after review by ETS personnel. It also allowed re-encoding of specific words and phrases after review for naturalness in concatenation on the actual hardware in the laboratory and prior to production.

Auditioning of potential speakers for the encoding task was held with respondants to local advertising by ATL. The speaker candidates were all professional announcers, or enrolled in local college communications courses. All had formal voice (speech) classes. Selection of the successful candidate was based on voice quality, compatibility with the encoding system, and compatibility with the application. Since the editing of the speech data is the most labor-intensive part of the process, compatibility with the encoding system ranked high in the selection process.

Each candidate was first auditioned in a studio setting where audio tapes were made of specific vocabulary words and phrases used in the M1 and previous Tutor applications. The tapes were then digitized at ATL's facilities and each speaker's voice subjected to the editing process. Listening tests comparing the final edited versions were used, along with the relative editing times for the selection of a set of potential candidates. Each member of the selected group was further auditioned at ATL's facility using direct speech encoding and edititng. From a field of 8 candidates a single speaker and an alternate were selected. Encoding then proceeded using the selected speaker in 4 to 6 hour sessions that included preliminary editing and re-encoding of unsuitable words. Post editing sessions by ATL staff completed the preparation of the speech data for use in the Authoring System.

The actual speech data generated was compatible with the older speech data formats used in the Tutor for the Mathematics and MOS 13B Vocabulary Modules, although the speech data itself was subsequently compiled into the new M1 format that is not compatible with the older forms.

Hardware Production. Hardware for the M1 Plug-in Module followed that of earlier modules. The Tutor Hardware Specification was sufficient for

production purposes, and 20 such Modules were manufactured. These were functionally compatible with the HHTA and mechanically compatible with both the HHTA and the Tutor.

COURSEWARE DEVELOPMENT

The primary source data for the HHTA was a set of Study Guides that already existed at the beginning of the project. Thus, the major goal was rearranging these guides into an efficient format for the HHTA. For example, battlefield scenarios that were bound together in one of the Study Guides were assigned to appropriate places among the 27 instructional units. As a minimum, each unit consists of a pretest and explanation section. Five units also have Picture Battles, and five units have Word Wars. Each of these features is described below.

Pretest and Explanation

Every instructional unit begins with a brief multiple-choice pretest. The questions and answer choices are printed in the book, and the soldier responds by pushing one of the A-E keys on the keyboard. After the pretest, the HHTA instantly evaluates the soldier's performance, and allows soldiers with no errors to proceed immediately to the next unit. For soldiers who made errors, the HHTA displays the answer choice they selected followed by the correct response. Thus, this test review becomes the first step in the instructional process.

Next, soldiers who made errors on the pretest are directed to begin reading the explanatory text. Frequent questions are sprinkled throughout the text to ensure that attention and comprehension are maintained. The HHTA provides immediate corrective feedback on these items, but errors should be rare if the soldier is reading carefully.

In the vocabulary module, the "SAY" key was used to make the HHTA pronounce target words that were underlined in the text with code numbers under them. The soldier pushed "SAY" and then the number under the word that he wanted to hear. In the fire commands instruction the use of the "SAY" key is quite different; it is used to provide a brief explanation of incorrect answers. Instead of entering responses on the A-E keys, the soldier makes a selection by pushing "SAY" then 1, 2, 3, or 4. This activates the HHTA'S digitized voice system. For example, a page in the book shows a picture of a battlefield scene with several potential targets labeled 1 to 4, and the text asks the student to identify the most dangerous threat. For one incorrect answer, the HHTA says "No, out of range, try again" and for another incorrect answer it says "No, can't kill you, try again." Through this type of oral feedback the soldier learns not only which answers are incorrect, but <u>why</u> they are incorrect. Although this information could be presented through the display screen instead of the voice system, it would be considerably more distracting, as the soldier would have to repeatedly shift attention from the picture of the battlefield scene to the display screen. Thus, while the use of voice technology in this application was not as crucial as it was for word pronunciation in vocabulary instruction, it still adds a different, valuable dimension to the instructional process.

A sample of one instructional unit (Unit 9) is presented in Appendix A.

Word War

The logic behind the increasing ratio review used on Word War (Siegel and DiBello, 1980) applies to many different rote memorization tasks, not just vocabulary learning. In the fire commands module it is used to provide practice in weapon/ammunition selection, and in the identification of the name of threat weapons, and in the appropriate target description for the description element of the fire command. For the weapon/ammunition selection routine, the screen first presents a situation (e.g., T-72 at 1000 meters), followed by three answer choices, presented one at a time (e.g., SABOT, HEAT, M-240). The soldier is instructed to push "GO" when the correct answer appears on the screen. The Word Wars for threat weapon identification were added when data from a preliminary field trial indicated that some soldiers had difficulty reading the text because they did not know, for example, that an SPG-9 is a recoilless anti-tank gun.

Sample Word War questions and answer choices are presented in Appendix A.

Picture Battle

In this game-like activity the HHTA's voice system asks a question based on a picture in the book, and the soldier responds on the keyboard. The display screen is used to keep score. With each correct answer a "projectile" formed by the dots on the display screen moves one step from left to right across the screen. For each incorrect answer an "enemy" projectile moves across the screen in the opposite direction. The object of the game is to destroy the enemy target before the enemy destroys you. Hitting the enemy target is accompanied by sound effects of a shell exploding. For vocabulary instruction, Picture Battle was used to reinforce an association between the spoken name of an object and a pictorial representation of the object (e.g., the Tutor would say "equilibrator" and the soldier would find the picture of an equilibrator), eliminating entirely the need to read anything. Although fire commands instruction did not require a task with no reading requirement, the game-like score-keeping features of Picture Battle could still be used to good advantage. In one implementation, a battlefield scene is pictured and a situation described in the text; when the HHTA's voice asks "Initial Fire Command" the soldier must select the appropriate fire command for the pictured situation. Immediate corrective feedback is provided and the appropriate projectile advances across the screen, then the soldier is asked to turn to the next battlefield scene and the process is repeated.

FIELD TEST

Introduction

The field trial was divided into two phases. Phase I was a test of the draft paper-based materials, prior to completion of the computerized plug-in modules. Phase II was a test of the complete system.

Phase I

During the first phase the preliminary text was administered to 19 soldiers in one-on-one sessions. The soldiers were reservists who would be expected to take over as instructors in M-1 tanks in the event of mobilization, but as a group they had very little hands-on experience with the M-1. Ambiguities and unclear sections in the text were noted and the materials were evaluated for overall difficulty level. Several minor problems were identified and corrected for the final version of the text. One major shortcoming in the draft materials was an assumption that all soldiers would be familiar with the names of basic threat weapons (e.g., that a T-72 is a tank and that a SAGGER is an antitank missle); in fact, several soldiers were not familiar with these names. This problem was addressed by some rewriting of the materials and by the addition of a Word War that specifically addressed the problem of names for threat weapons.

Phase II

Phase II was a test of the complete system including the books and plug-in modules. This test was conducted with one group of soldiers on 21 January, and with another group on 23 January, 1986. Although, optimally, soldiers might be asked to work with the HHTA for 30-60 minutes a day for a period of one or two weeks, scheduling constraints in the BNOC calendar made it necessary for soldiers to complete as many units as possible in a single day, preceeded by a pretest and followed by a posttest. Soldiers in Group 1 were pretested at 0800 hour, trained from 0900 - 1604 hours with 1 1/2 hours off for lunch, and completed the posttest from 1800 to 1900 hours the same day. Soldiers in Group 2 trained from 1345 to 1640 hours (preceded by the pretest and followed by the posttest).

Test results. The same test was used for the pretest and posttest. It was divided into two sections (one section for units 1-12 and the second section for units 13-27). The test consisted of both multiple choice and fill-in items. Maximum possible score was 53 for units 1-12 and 27 for units 13-27, with a total maximum score of 80.

All 13 soldiers in the field trial were enrolled in BNOC and all but one were high school graduates. For soldiers in Group 1, experience with the M-1 Abrams tank ranged from 1 month to 54 months, with an average of 24 months. In Group 2, the experience level was slightly higher on average (30.9 months) with a range of 4 to 48 months.

Results of the pretesting and posttesting for Group 1 are summarized in Table 3. Mean gain from pretest to posttest was 13.6 points. Gains were

Table 3

Field Test Results

Soldier	Months M1 Experience	Units 1-12 Pretest	Units 1-12 Posttest	Units 13-27 Pretest	Units 13-27 Posttest	Total Pretest	Total Posttest	Gain
1	1	29	39	18	18	47	54	10
2	40	35	40	20	24	55	64	9
3	24	31	43	15	19	46	62	16
4	3	28	44	18	22	46	66	20
5	54	34	41	15	21	49	62	13
MEAN	24.4	31.4	41.4	17.2	20.8	48.6	62.2	13.6
Standard Deviation	23.0	3.0	2.1	2.2	2.4	3.4	3.3	4.5

substantially higher for units 1-12 (10 points) than for units 13-27 (3.6 points). The relatively low gain for units 13-27 may reflect greater difficulty of these units or a fatigue factor at the end of the long instructional period. Follow-up studies with spaced instructional sessions should be conducted.

Results for Group 2 are presented in Table 4. Because no soldier in this

Table 4

Group 2 Field Test Results

Soldier	Months M1 Experience	Units 1-12 Pretest	Units 1-12 Posttest	Units 13-17 Pretest	Units 13-17 Posttest	Total Pretest	Total Posttest	Gain
6	47	39	43	8	8	47	51	4
7[a]	4	30	30	4	5	34	35	1
8	24	40	40	7	8	47	48	1
9[b]	9	37	35	5	8	42	43	1
10	45	36	39	6	7	42	46	4
11	34	45	51	8	8	53	59	6
12	48	37	36	7	8	44	44	0
13	36	38	45	6	6	44	51	7
MEAN	30.9	37.8	39.9	6.4	7.3	44.1	47.1	3.0
Standard Deviation	17.1	4.2	6.5	1.4	1.2	5.4	7.0	2.6

[a] completed only 15 units

[b] notified of death in family immediately before taking posttest

group completed more than 17 units, only the 8 items relevant to units 13-17 are reported for the second section of the pretest/posttest. Total possible score for this group was 61 points, instead of the 80 points possible for Group 1. In contrast to the substantial gain for Group 1, gain in Group 2 was

only 3 points. Group 2 may have been less motivated because they were asked to work with HHTA immediately after working on the full-scale simulator, whereas Group 1 worked with the HHTA on the day before they were scheduled to train on the simulator. Note also that the posttest scores of both groups on units 1-12 were very similar (41.1 vs. 39.9), although the pretest scores in Group 1 were substantially lower than the scores in Group 2 (31.4 vs. 37.8). This suggests that the HHTA may be useful in bringing performance up to a certain level rather than contributing a fixed amount of gain. Thus, the HHTA may be most useful for the students who are in greatest need. The above comments are highly speculative based on the very small sample tested and need to be verified with a larger-scale field trial.

Soldier reactions. After completing the posttest soldiers in both groups were asked to write their general reactions to the HHTA, and to record what they most liked or disliked. General reactions were uniformly positive. The HHTA was described as "great to use," "amusing", "a very helpful piece of equipment," "a very good teacher," "the teaching aid of the future," etc. The HHTA was seen as useful to train a man with no prior knowledge as well as a refresher for more experienced tankers. More specifically, positive comments focused on ease of use, self-pacing, explanations of incorrect answers, audio feedback, games that were fun to win, and the ability of the HHTA to boost confidence as well as skills. On the negative side, there were a number of comments suggesting that instructional sessions with the HHTA should be limited to 30-60 minutes. Only two changes were suggested: one soldier thought the front needed to be tilted up and another soldier thought that a reset button would be helpful.

Hardware performance. No hardware problems were experienced. The HHTAs were fully charged before the start of the field trial and all completed the 27 instructional units without recharging. One problem in the text was noted; all item numbers in the explanation section of unit 16 are off by one (7 should be 8, 8 should be 9, etc.).

Conclusion. The field test was not, and was not intended to be, a full-scale program/product evaluation. But within its limited scope it suggested that (1) the HHTA hardware and software functions as designed, (2) the courseware effectively presents fire commands instruction, and (3) soldiers like the learning interaction with the HHTA.

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Appendix A

Sample Unit

UNIT 9
SINGLE TARGET MACHINEGUN ENGAGEMENTS: THE INITIAL FIRE COMMAND

PRETEST

1. The ALERT element for a gunner engagement is:

   A. MACHINEGUN
   B. GUNNER MACHINEGUN
   C. CALIBER FIFTY
   D. GUNNER
   E. Don't know

2. For the EXECUTION element of COAX machinegun engagements, the TC would:

   A. Select a weapon.
   B. Announce FIRE.
   C. End the engagement.
   D. Don't know.

3. A wheeled vehicle is always announced as:

   A. PC
   B. TANK
   C. TRUCK
   D. TROOPS
   E. Don't know

4. A truck-mounted antitank guided missile system can be identified as:

   A. PC
   B. MISSILE
   C. ANTITANK PC
   D. ANTITANK TRUCK
   E. Don't know

5. If the TC can lay the gun for direction and elevation, he may omit the:
   A. EXECUTION element
   B. DESCRIPTION element
   C. DIRECTION element
   D. ELEVATION element
   E. Don't know

6. AT MY COMMAND means:
   A. Wait until I command "FIRE."
   B. The TC *will take the command.*
   C. Crewmember is to conduct engagement on his own.
   D. A new ALERT element will be given.
   E. Don't know.

7. Which method of laying the gun for direction is the <u>least</u> desirable and should be used only when immediate target suppression is necessary and the gunner cannot identify the target?

   A. Caliber Fifty Tracer method
   B. Traverse method
   C. Reference Point and Deflection method
   D. Commander's GPS Extension method
   E. Don't know

8. Range data is announced in the fire command in:

   A. Even hundreds
   B. Even thousands
   C. Digit by digit
   D. All of the above
   E. Don't know

UNIT 9
SINGLE TARGET MACHINEGUN ENGAGEMENTS: THE INITIAL FIRE COMMAND

EXPLANATION

A correctly stated initial fire command may contain as many as six elements (parts). They are:

- ALERT (AND/OR WEAPON IF TC IS TO FIRE)
- AMMUNITION/WEAPON
- DESCRIPTION
- RANGE
- DIRECTION (optional)
- EXECUTION

Each element helps the TC explain the engagement to his crew.

THE ALERT ELEMENT

The first element of the initial fire command is announced by naming a crew member or weapon. For example, the TC might announce:

- GUNNER
  or
- LOADER
  or
- CALIBER FIFTY

9. The ALERT element for a loader engagement is:
   A. LOADER, MACHINEGUN
   B. LOADER
   C. MACHINEGUN
   D. LOADER, TWO-FORTY

The ALERT element serves two purposes. The first purpose is to tell the crew that an engagement is going to take place. The second purpose is to tell who will be involved in the engagement. For example,

- If the TC announces GUNNER—and wants the gunner to fire the weapon, he has announced who will conduct the engagement.
- If the TC announces CALIBER FIFTY—he has announced to the crew that he will be using his weapon for the engagement.

10. For the ALERT element of machinegun engagements, if the TC announces GUNNER, he has:

    A. Announced that he will be using his weapon.

    B. Announced who will be involved in the engagement.

    C. Executed the initial fire command.

    D. Ended the engagement.

THE AMMUNITION/WEAPON ELEMENT

The second element of the initial fire command tells the crew which ammunition/weapon will be used for the engagement. For example, the TC might announce:

$\boxed{\bullet\ \text{SABOT}}$ or $\boxed{\bullet\ \text{COAX}}$ or $\boxed{\bullet\ \text{"240"}}$

11. When you are going to engage a T-72, the AMMUNITION/WEAPON element is:

    A. COAX
    B. CALIBER FIFTY
    C. SABOT
    D. TWO-FORTY

THE DESCRIPTION ELEMENT

The third element of the initial fire command identifies the target to the gunner/loader. If there are several similar targets it tells the gunner/loader which target to engage first. Most targets can be designated by the following terms:

TYPE TARGET	ANNOUNCED AS
Tank or tank-like target	TANK
Unarmored vehicle	TRUCK
Armored personnel carrier	PC
Helicopter	CHOPPER
Fixed-wing aircraft	PLANE
Personnel	TROOPS
Machinegun	MACHINEGUN
Antitank Gun, Antitank Missile, or Towed Artillery Piece	ANTITANK

For all other targets, use the briefest possible term which clearly describes the target.

12. A helicopter target is always announced as:

    A. HELICOPTER
    B. PLANE
    C. AIRCRAFT
    D. CHOPPER

At times, there may be combination targets, such as a truck-mounted antitank guided missile system. They can be identified by combining terms, e.g., ANTITANK TRUCK.

At other times, there may be multiple targets. Here, the TC identifies the number of targets he acquires, e.g., GUNNER–COAX–TWO TRUCKS. He then designates which target to engage first, e.g., RIGHT TRUCK. The TC may continue the fire command until all targets are destroyed or no longer visible.

13. If four trucks are on the battlefield, the <u>best</u> target description might be:

A. TRUCKS
B. FOUR TRUCKS, LEFT TRUCK
C. FOUR TRUCKS
D. LEFT TRUCK

THE DIRECTION ELEMENT

The fourth element, DIRECTION, is omitted by the TC if he can lay the gun for direction and elevation. If he cannot, he can use one of four methods:

- TRAVERSE METHOD
- REFERENCE POINT AND DEFLECTION METHOD
- COMMANDER'S GPS EXTENSION METHOD
- CALIBER FIFTY TRACER METHOD

Traverse Method. The TC tells the gunner TRAVERSE—LEFT (or RIGHT). The gunner traverses rapidly in the direction announced. As the gun tube nears the target, the TC announces STEADY and the gunner slows his traverse. When the gun tube is on target, the TC announces ON.

Reference Point and Deflection. The target reference point must be one that the gunner can recognize easily. For example, the TC's command might be REFERENCE POINT–BRIDGE–TRAVERSE RIGHT. The gunner identifies the reference point and traverses right, looking for the target.

14. Using the traverse method, when the gun tube is laid on target, the TC announces:

    A. STEADY
    B. TRAVERSE–LEFT (or (RIGHT)
    C. REFERENCE POINT
    D. ON

Commander's GPS Extension Method. TC acquires a target and observes through the GPS extension. He then uses the traverse method to lay the gun on target.

<u>Caliber Fifty Tracer Method.</u> This method is the least desirable in laying the gun for direction. It should be used when immediate target suppression is necessary and the gunner cannot identify the target. To use this method, main gun and Cal .50 must be in the same target area so the gunner can see the tracers. The TC will announce the first three elements of the fire command followed by "WATCH MY TRACER." For example:

GUNNER
SABOT
TANK....
UP (Loader)
CANNOT IDENTIFY (Gunner)
WATCH MY TRACER

15. WATCH MY TRACER is which element of a fire command?

A. TRACER element
B. IDENTIFICATION element
C. DIRECTION element
D. TRAVERSE element

THE RANGE ELEMENT

The fifth element is omitted by the TC if the LRF is operational. With an operational LRF, the gunner will lase to the target and the TC will evaluate every range. If the LRF is not operational or environmental conditions prevent its use, one of the following two methods will be used:

- KNOWN RANGE
- ESTIMATED RANGE

Known Range. By knowing the range to probable target areas, the crew can reduce engagement time and improve accuracy by indexing the known tank-to-target range into the commander's control panel (CCP). Known range can be used from a previous target engagement.

Estimated Range. When engaging targets and the LRF is inoperative or unusable and range is unknown, the TC must estimate the range to the target.

If the TC announces ONE EIGHT HUNDRED, the gunner will shift to the GAS and use the appropriate reticle and range line. If the TC announces INDEX ONE EIGHT HUNDRED, the gunner will index the range into the CCP and use the GPS.

Range data is always announced in the fire command in even hundreds, thousands, or digit by digit.

Examples of announced range include:

RANGE	GPS ANNOUNCED AS	GAS ANNOUNCED AS
900 m	INDEX NINE HUNDRED	NINE HUNDRED
2,000 m	INDEX TWO THOUSAND	TWO THOUSAND
1,100	INDEX ONE ONE HUNDRED	ONE ONE HUNDRED
860 m	INDEX EIGHT SIX ZERO	NINE HUNDRED
3,040 m	INDEX THREE ZERO FOUR ZERO	THREE THOUSAND

16. How is 2060 meters announced by the TC (GPS)?
    A. TWO THOUSAND SIXTY
    B. INDEX TWO THOUSAND SIXTY
    C. INDEX TWO ZERO SIX ZERO
    D. INDEX TWO THOUSAND SIX ZERO
    E. INDEX ZERO SIX ZERO

17. How is 960 meters announced by the TC (GAS)?
    A. INDEX ONE THOUSAND
    B. ONE THOUSAND
    C. *INDEX NINE SIX ZERO*
    D. INDEX NINE HUNDRED SIXTY
    E. NINE SIX ZERO

THE EXECUTION ELEMENT

This last element tells the crew when the target will be engaged. The following four examples show all possible EXECUTION elements.

EXECUTION ELEMENT	WHO	WHEN
FIRE	The crew member named in the alert element.	NOW
FIRE AND ADJUST	The crew member named in the alert element. He will also adjust his own fire and continue firing until target destroyed or until told to end the engagement.	NOW
AT MY COMMAND	The crew member named in the alert element.	Upon hearing FIRE or FIRE AND ADJUST
FROM MY POSITION	The TC will take the engagement.	NOW

18. FIRE AND ADJUST means:

A. Crew member is to conduct engagement on his own.
B. A subsequent fire command will be issued.
C. A new ALERT element will be given.
D. The description is incorrect.

Here is an example of an initial fire command for machinegun engagements:

TC COMMANDS	ELEMENTS
GUNNER	Alert
COAX	Ammunition/Weapon
TROOPS	Description
DIRECT FRONT–ON	Direction is optional. Also, ON is not an element, but a crew duty performed by the TC to help the gunner identify the same target.
FIRE	Execution

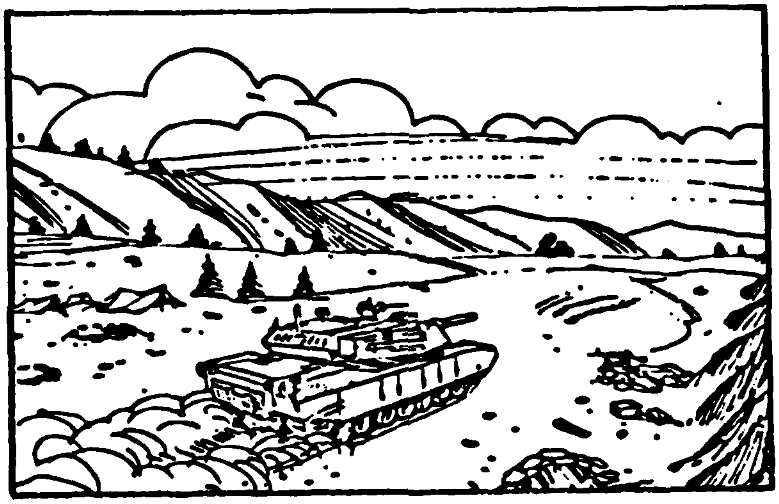
19. If the AMMUNITION/WEAPON element of an initial fire command is TWO-FORTY, the ALERT element is:

A. LOADER
B. GUNNER
C. ON
D. TARGET

PICTURE BATTLE

Unit 9

PICTURE BATTLE 1



Unit 9

THE SITUATION

- You are in a deliberate attack.
- M1 is fully operational, SABOT loaded.
- You see a BM-21 mounting 122 mm rocket launchers to your left at 1400 meters.

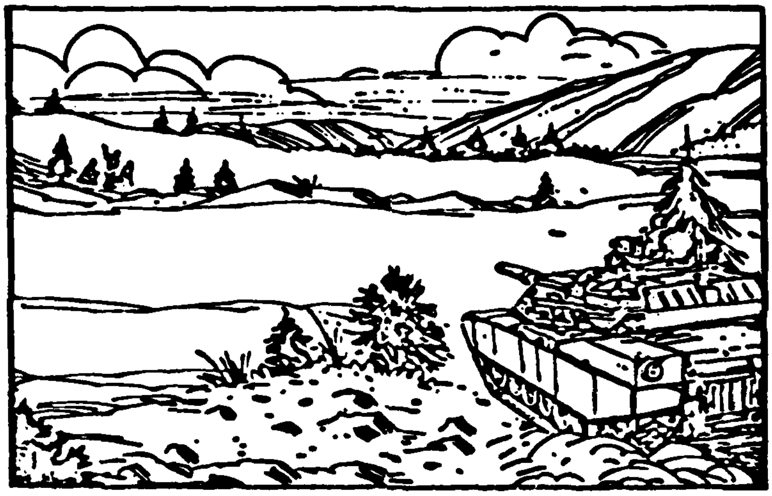
A	B	C	D
GUNNER SABOT TRUCK	GUNNER COAX TRUCK	GUNNER CALIBER FIFTY TRUCK	CALIBER FIFTY

Push GO for question.

Turn the page for the next Picture Battle

Unit 9

PICTURE BATTLE 2



THE SITUATION

- You are in a defensive position.
- M1 is fully operational, SABOT loaded.
- You see a manpack SAGGER team to your left at 750 meters.

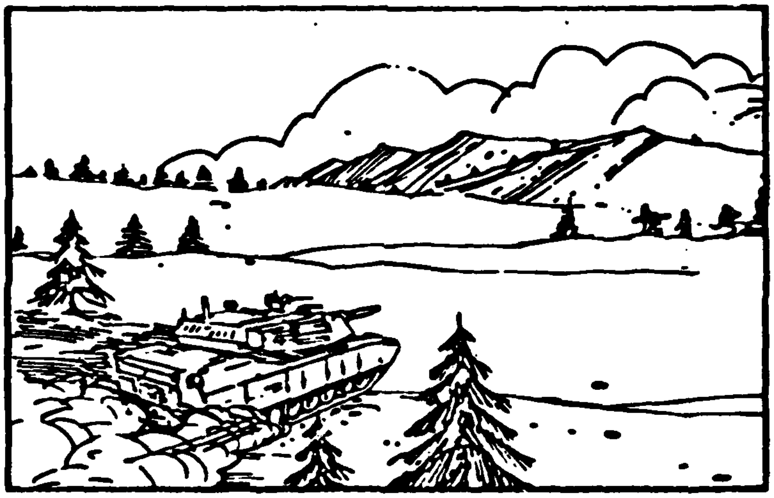
A	B	C	D
CAL .50 ANTITANK TEAM	LOADER M240 ANTITANK TEAM	GUNNER M240 ANTITANK TEAM	GUNNER COAX ANTITANK TEAM

Push GO for question.

Turn the page for the next Picture battle

Unit 9

PICTURE BATTLE 3



Unit 9

THE SITUATION

- You are in a deliberate attack.
- M1 is fully operational, SABOT loaded.
- You see an SPG-9 recoilless antitank gun preparing to engage you at 1000 meters.

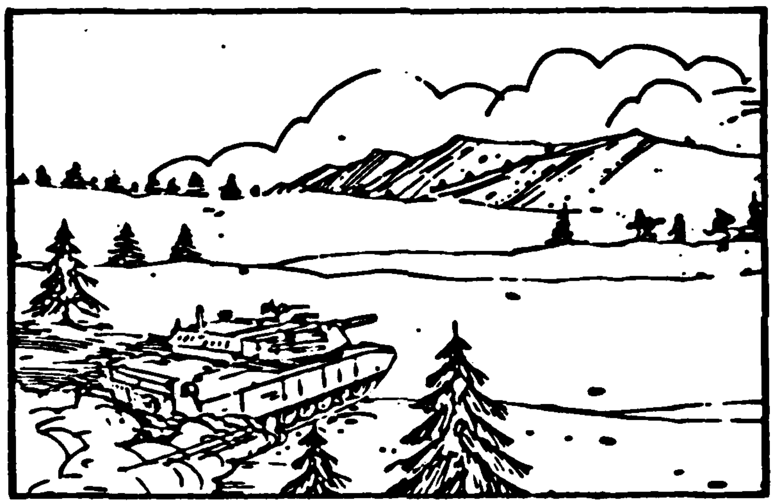
A	B	C	D
CALIBER FIFTY	GUNNER CALIBER FIFTY	GUNNER CALIBER FIFTY ANTITANK	GUNNER SABOT ANTITANK

Push GO for question.

Turn the page for the next Picture Battle

Unit 9

PICTURE BATTLE 4



THE SITUATION

- You are in a deliberate attack.
- LRF has failed; "F" is in gunner's primary sight extension (GPSE).
- Range in GPSE remains unchanged; 2810.
- Round loaded is HEAT.
- You see an SPG-9 recoilless antitank gun preparing to engage you at 750 meters.

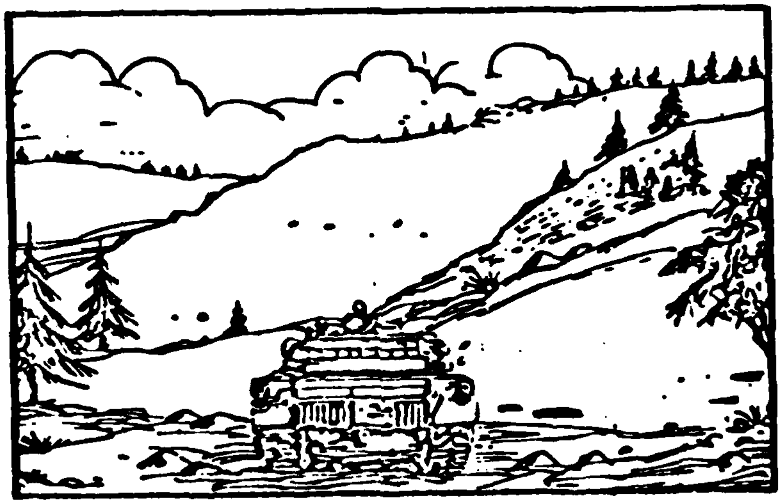
A	B	C	D
GUNNER CALIBER FIFTY ANTITANK	LOADER CALIBER FIFTY ANTITANK	GUNNER COAX ANTITANK	LOADER COAX ANTITANK

Push GO for question.

Turn the page for the next Picture Battle

Unit 9

PICTURE BATTLE 5



THE SITUATION

- You are in a traveling overwatch position.
- All crew members are acting as observers.
- Suddenly, without warning, the loader opens fire on an RPG-7 to the right of the main gun center line. He destroys it.

[A] Loader's machinegun should only be used for area or aerial targets.
[B] Loader's machinegun should only be fired at targets to the left of the main gun center line.
[C] When acting as an observer, loader must not initiate his own fire commands.
[D] All of the above.
[E] None of the above.

Push [GO] for question.

If no winner at this point, go back to Picture Battle 1 for Unit 9

UNIT 9 KEY

Unit 9

1 D
2 B
3 C
4 D
5 C
6 A
7 A
8 D

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9 B
#10 B
#11 C
#12 D
#13 B
#14 D
#15 C
#16 C
#17 B
#18 A
#19 A

Picture Battle 1: "INITIAL FIRE COMMAND?" D
Picture Battle 2: "INITIAL FIRE COMMAND?" D
Picture Battle 3: "INITIAL FIRE COMMAND?" A
Picture Battle 4: "INITIAL FIRE COMMAND?" C
Picture Battle 5: "INITIAL FIRE COMMAND?" D

Appendix B

Sample Word War

UNIT 5 WORD WAR

<u>WORDS</u>:

HEAT
SABOT
COAX
LOADER'S 240
CAL .50

1. T-72, 1700M, BEST

   SABOT

2. Manpack SAGGER, 1800M, Best

   CAL .50

3. 152MM Howitzer, 2500M, Best

   SABOT

4. T-72, 2000M, 2nd Best

   HEAT

5. Troops, 1500M, Best

   CAL .50

6. RPG, 750M, Best

   COAX

7. Truck, 800M, Best

   COAX

8. T-12A, 2000M, 2nd Best

   SABOT

9. BMP, 1000M, 2nd Best

   SABOT

10. MIG-23, Low Level, 2nd Best

    LOADER's M240